

What is claimed is:

1. A semiconductor device comprising:
a first dielectric layer;
a first gate formed on the first dielectric layer; and
a second dielectric layer formed on the first gate,
wherein the first gate includes a first nitrogen-rich region substantially adjacent to the first dielectric layer, a substantially separate second nitrogen-rich region substantially adjacent the second dielectric layer, and a reduced-nitrogen region located between the first nitrogen-rich region and the second nitrogen-rich region, the reduced-nitrogen region having a lower concentration of nitrogen than the first nitrogen-rich region and the second nitrogen-rich region.
2. The semiconductor device as recited in Claim 1, wherein the first dielectric layer comprises silicon dioxide.
3. The semiconductor device as recited in Claim 1, wherein the second dielectric layer comprises a plurality of films selected from a group comprising silicon dioxide and silicon nitride.
4. The semiconductor device as recited in Claim 1, wherein the first gate comprises doped polysilicon.
5. The semiconductor device as recited in Claim 1, wherein the first nitrogen-rich region includes between about 0.01% and about 1% atomic percentage of nitrogen.
6. The semiconductor device as recited in Claim 1, wherein the second nitrogen-rich region includes between about 0.01% and about 1% atomic percentage of nitrogen.
7. The semiconductor device as recited in Claim 1, wherein the lower concentration of nitrogen in the contiguous reduced-nitrogen region is less than about 0.001% atomic percentage of nitrogen.
8. The semiconductor device as recited in Claim 1, further comprising a second gate formed on the second dielectric layer and over the first gate to form a non-volatile memory cell within the semiconductor device.
9. The semiconductor device as recited in Claim 1, wherein the first and second nitrogen-rich regions include implanted nitrogen ions.
10. A method for forming a semiconductor device, the method comprising:
forming a first dielectric layer;

forming a first gate on the first dielectric layer;
forming at least a portion of a second dielectric layer on the first gate; and then
forming a first nitrogen-rich region within the first gate and substantially adjacent to the first dielectric layer, and a second nitrogen-rich region within the first gate and substantially adjacent to the second dielectric layer.

11. The method as recited in Claim 10, wherein the step of forming the first nitrogen-rich region and the second nitrogen-rich region within the first gate further comprises:

implanting nitrogen ions through the second dielectric layer and into the first gate, the implanted nitrogen ions forming a first nitrogen concentration profile within the first layer; and

causing the first nitrogen concentration profile to be altered to form a second nitrogen concentration profile within the first gate, the second nitrogen concentration profile comprising the first nitrogen-rich region, the second nitrogen-rich region and a contiguous reduced-nitrogen region located between the first nitrogen-rich region and the second nitrogen-rich region, the contiguous reduced-nitrogen region having a lower concentration of nitrogen than the first nitrogen-rich region and the second nitrogen-rich region.

12. The method as recited in Claim 11, wherein the step of causing the first nitrogen concentration profile to be altered further comprises causing the first nitrogen-rich region to include between about 0.01% and about 1% atomic percentage of nitrogen.

13. The method as recited in Claim 12, wherein the step of causing the first nitrogen concentration profile to be altered further comprises causing the second nitrogen-rich region to include between about 0.01% and about 1% atomic percentage of nitrogen.

14. The method as recited in Claim 11, wherein the step of causing the first nitrogen concentration profile to be altered to form the second nitrogen concentration profile within the first gate further comprises causing the lower concentration of nitrogen in the contiguous reduced-nitrogen region to include less than about 0.001% atomic percentage of nitrogen.

15. The method as recited in Claim 10, wherein the step of forming at least a portion of a second dielectric layer on the first gate includes forming a first silicon dioxide film on the first gate prior to the step of forming the first nitrogen-rich region and the second nitrogen-rich region within the first gate.

16. The method as recited in Claim 15, wherein the step of forming at least a portion of a second dielectric layer on the first gate further includes forming a silicon nitride film on the first silicon dioxide film prior to the step of forming the first nitrogen-rich region and the second nitrogen-rich region within the first gate.

17. The method as recited in Claim 16, wherein the step of forming at least a portion of a second dielectric layer on the first gate further includes forming a second silicon dioxide film on the first silicon dioxide film prior to the step of the step of forming the first nitrogen-rich region and the second nitrogen-rich region within the first gate.

18. The method as recited in Claim 11, wherein the step of implanting nitrogen ions through the second dielectric layer and into the first gate uses an ion implantation energy of between about 10 and about 30 KeV to provide a dosage of between about 1×10^{14} and about 1×10^{16} nitrogen ions/cm².

19. The method as recited in Claim 11, wherein the step of causing the first nitrogen concentration profile to be altered to form a second nitrogen concentration profile within the first gate further includes applying thermal energy to the first gate.

20. The method as recited in Claim 19, wherein the step of applying thermal energy to the first gate causes an internal temperature within the first gate of between about 900 and about 1100 C°.

21. A method for nitrogen doping a polysilicon layer, the method comprising:

forming a polysilicon layer in a semiconductor device, the polysilicon layer sharing a first interface with an underlying dielectric layer and a second interface with an overlying dielectric layer;

implanting nitrogen through the overlying dielectric layer and substantially into a polysilicon layer; and

heating the polysilicon layer to cause the implanted nitrogen to form a first nitrogen-rich region substantially adjacent to the underlying dielectric layer and a substantially separate second nitrogen-rich region substantially adjacent the overlying dielectric layer, thereby leaving a reduced-nitrogen region located within the polysilicon layer between the first nitrogen-rich region and the second nitrogen-rich region, wherein the reduced-nitrogen region always has a lower concentration of nitrogen than the first nitrogen-rich region and the second nitrogen-rich region.

22. A method for reducing electron-trap density at an interface, the method comprising:

forming a gate;

forming a dielectric layer on the gate to create a gate/dielectric interface; and

implanting ions into the gate, whereby the ions reduce the electron-trap density at the gate/dielectric interface.

23. The method as recited in Claim 22, further comprising altering a profile of a concentration of the ions in the gate such that an ion-rich region is formed at the gate/dielectric interface.

24. The method as recited in Claim 23, wherein the ions are nitrogen ions.

25. The method as recited in Claim 24, wherein the step of altering the profile includes heating the gate.

26. The method as recited in Claim 25, wherein the step of heating the gate includes using a rapid thermal anneal to heat the gate.